WAX SHELL IMITATION CANDLE WITH IMPROVED RESISTANCE TO CRACKING

BACKGROUND OF THE INVENTION

[001] 1. Technical Field:

[002] The invention relates to wax imitation candles and more particularly to an imitation candle resistant to cracking at low temperatures.

[003] 2. Description of the Problem:

[004] Many people find candle light pleasant. The flickering of light and movement of shadows across a floor or on a nearby wall can be almost hypnotically soothing. As a result, candles have remained popular for generations since the invention of more practical electrical lighting, especially for decorative and mood setting purposes.

[005] Consequently, numerous manufacturers have attempted to meet a demand for a candle like luminary using electrical illumination. A now popular imitation candle is taught in International Publication Number WO 03/016783 A1. This imitation candle uses an internal LED as a light source within a solid appearing body. While a classical image of a candle is of a long, thin, tapering rod, which stands upright in a candle stick and which leaves its flame exposed as it burns down, this imitation candle comes as a relatively short to circumference block or cylinder which is self supporting. Such candles commonly leave the outer wall of the candle intact as the candlewick burns down. When this happens, the candle flame is no longer directly visible when viewed from the side. This results in a diffuse, flickering glow visible through the paraffin wall of the candle, which is imitated by the external shape of the imitation candle.

[006] While the imitation candle of WO 03/016783 appears to be a solid body to users it is in fact hollow. This provides space for the installation of batteries, the LED, LED excitation circuitry and possibly light directing internal components. In addition, the contour of the void's internal surface may be chosen for light transmission issues. While the imitation candle can readily be made in plastic, fabricating it in more realistic wax has presented particular problems.

[007] Wax is highly susceptible to compressive and tensile stress. Waxes also tend to have

high coefficients of thermal expansion. Differential heating and cooling of sections of a cast wax body introduces stress. Stress tends to be focused along sharp corners and edges of a wax body. Stress can occur during manufacturing and shipping of the wax shell imitation candles when the imitation candles are subjected to rapid cooling or great temperature extremes, respectively. The cavity adds the problem of internal edges, as well as reducing the strength of the body compared to a solid wax body. In addition, the insert on which battery, excitation circuitry and the LED are mounted will typically be constructed by plastic with the wax body being formed in part on the insert body. Wax will typically have a higher coefficient of expansion than the plastic does, which results in additional stress as temperature of the body decreases and contributes further to the problems of the inherent weakness of wax.

[008] Wax bodies, such as candles, are formed by a process of casting. Where it is desired to incorporate a plastic module in the wax body the plastic module may be fixed in position in a mold and hot wax poured around the module, adding wax as earlier poured wax cools and shrinks, until all voids around the module are filled. Alternatively, a wax shell can be formed that produces the outer visible surfaces of the candle while leaving a space for the module. After the shell is produced a second pour is done to secure the module in position. The amount of wax in the second pour is less than in the first, with the attendant advantages of quicker cooling and faster production speeds. While true, solid wax candles have reasonable durability to withstand cold temperature induced stress, wax bodies made by either of the foregoing casting techniques have proven highly susceptible to cracking. Thin sections of the casting adjacent the module cool more rapidly than thicker sections. Leading edges of the imitation candle also cool rapidly. These sections of rapid cooling result in differential rates of contraction, which can easily result in formation of a crack to relieve stress. Once such a crack propagates into a thicker section of the body it can become a focal point for other stresses and can extend to encircle the imitation candle body.

SUMMARY OF THE INVENTION

[009] According to the invention there is provided an imitation candle. The imitation candle has a wax shell having a central cavity defined by an interior surface. A artificial lighting module, which tends to exhibit a different thermal coefficient of expansion than the wax, is positioned in the central cavity. A bonding layer between a portion of the module and the interior surface of the wax shell retains the module in the shell. The bonding layer leaves a gap between the insert and the interior surface near any exterior edges of the wax shell. The gap is preferably filled with air.

[0010] Additional effects, features and advantages will be apparent in the written description that follows.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself however, as well as a preferred mode of use, further objects and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

[0012] **Figs. 1** and **2** are perspective views from different angles of a wax shell and artificial illumination source for insertion thereto.

[0013] **Figs. 3A** and **3B** are cross sectional views of wax shell imitation candles constructed in accordance with each of two preferred embodiments of the invention.

[0014] **Fig. 4** - **7** depict steps in a process for fabricating the wax shell imitation candle of **Fig. 3.**

DETAILED DESCRIPTION OF THE INVENTION

[0015] Referring now to **Figs. 1** and **2** a shell **10** and an insert or illumination module **12** which includes circuitry, batteries and a light emitting diode for insertion into the shell are shown from above and below. Shell **10** is a generally squat, cylindrical body, with dimensions common to free standing, thick walled candles. An upper surface **22** of shell **10** is depressed into the interior of the shell to simulate a previously burned candle the center of which is partially melted and consumed. Insert **12** fits into and is retained within cavity **14** defined by an interior surface **15** of shell **10.** Cavity **14** is open along a bottom surface of shell **10** and is slightly oversized, as described below, to admit insert **12.** Shell **10** is preferably a cast wax body. Insert **12** has an exterior casing **18** made enclosing the battery, circuitry and an LED enclosed in an upper surface **16** of the insert **12.** Insert **12** is introduced to cavity **14** lead by upper surface **16.** The wax material of shell **10** and the plastic material of casing **18** exhibit substantially different coefficients of thermal expansion. The present invention concerns mating of the interior surface of shell **10** and casing **18** of insert **12** to inhibit cracking of the wax of the shell.

[0016] Referring to **Figs. 3A** and **3B** some of the features of the invention as incorporated into

each of two preferred embodiment of the invention may be seen to advantage. The central depression in upper surface **22** begins spaced inwardly from a rounded circumferential exterior edge **27** with a shallow downwardly slanted ledge **26**, which terminates moving toward the vertical center axis of shell **10** in a rounded shoulder **24** where the upper surface drops to a central depression defined by a second shoulder **25**. Insert **12** is illustrated fitted into cavity **14** from the bottom of shell **10**. Cavity **14** is defined by an interior surface **15** which, in a fashion similar to the central depression in the upper surface **22**, has rounded transitions between portions of the surface which exhibit substantial intersecting angles *vis-a-vis* one another. Rounded transition **23** is characteristic forming a boundary between a cylindrically shaped, vertically oriented section of interior surface **15** and a horizontally oriented disk like section at the top of cavity **14**.

[0017] Insert **12** is undersized compared to the cavity **14** in which it is to be retained. Bonding between a plastic insert casing **18** is provided by bonding layer **20** which lines the upper portion of cavity **14** between casing **18** and interior surface **15**. As described below, bonding layer **20** is formed by a second pouring of a small quantity of molten wax into an inverted, but already cooled and hardened shell **10**. Bonding layer **20** is shaped by fitting insert **12** into cavity **14** while the second poured wax is still molten. Bonding layer **20** does not line all of interior surface **15** in the preferred embodiment, but only enough to cover casing **18** around LED **16** and about the top half of the main body of insert **12**. An air gap **30** surrounds the bottom half of insert **14** spacing the insert from interior surface **15**. The top **34** of illumination module **14** abuts an upper horizontal face **34** of interior surface **15**, displacing molten wax and positioning the illumination module vertically. Horizontal positioning of illumination module may be achieved by careful reference to the spacing between casing **18** and interior surface **15** and by the careful, mutually parallel orientation of the elements. The bottom surface of insert **12** is slightly recessed (2.5 mm) from the surrounding bottom surface of shell **10** allowing accurate determination disposition of the insert in cavity **14**.

[0018] While use of a bonding layer **20** is preferred due to the assurance of a good fit between the bonding layer and insert **12**, it is possible to substitute a molded or shaped shoulder **60** which is formed as part of interior surface **15** defining cavity **14**. As seen in **Fig. 3B** shoulder **60** is part of shell **12** and slants inwardly into cavity **14** partway into the cavity from the bottom surface of shell **10**. Construction of shell **10** to incorporate such a circumferential shoulder is easily done by modification of the bit used to shape cavity **14** or form **42**. It is important that a gap be left between the body of insert **12** and interior surface **15** in the lower part of cavity **14**. This saves processing steps. However, the difficulty in this technique is that extremely close tolerances in dimensional matching between the insert **12** and the shell **10** are required to avoid introducing stress on introducing the insert to cavity **14**. It may

be possible to time the introduction to a point while the wax of shell **10** is still slightly soft.

[0019] **Figs. 4** through **7** help illustrate a process for fabricating the imitation candle of the present invention. The first step of the process is to pour molten wax **11** into a mold **40** giving the body of wax which cools to form shell **10** its exterior shape. Mold **40** should be slightly taller then the desired eventual size of shell **10** to allow trimming of the cooled body to the desired size. Cavity **14** may be formed in one of two ways. In one process, a form **42** is held in the mold **40** to leave cavity **14** upon withdrawal from the hardened shell **10**. Alternatively, no form is used and the mold **40** is substantially filled with wax on the first pouring. In a preferred embodiment mold **40** is 111 mm deep allowing trimming of shell **10** to a desired height of 105 mm.

[0020] After pouring of the wax for shell **12** the wax is allowed to cool. Where no form is used the wax is allowed to cool until the wall thickness is at least 10 mm. Where a form **42** is used the wax is allowed to cool until the entire shell **10** has hardened. A water bath may be used to expedite the cooling process. If no form was used a hole is formed into the cooling body from what will be become the bottom surface of the shell to the interior, still molten wax. The mold is partially inverted to allow the molten wax to be poured out and reclaimed. Removal of the central, molten wax speeds the cooling process and relieves stress on the walls of shell **10**. The shell continues cooling, again potentially placed in a water bath to quicken the process. Mold **40** is advantageously shaped to impress an upper surface central depression into shell **10**. Where, however, the mold did not incorporate such a shape, a bit contoured with the cross section of the upper surface may be used to shape the upper surface after withdrawal of the shell **10** from mold **40**.

[0021] The position of insert **12** is controlled by the depth of cavity **14**. An inner bit may be used trim the bottom of shell **10** and to machine cavity **40** where no interior form **42** is used, or where adjustment of the shape of a cavity left by a form is required. Shell **10** should be properly fixtured during shaping with a bit to insure a uniform core depth and candle height.

[0022] With the shell **10** fully hardened and the shape of cavity **14** finalized, shell **10** is reinverted and a second pour **46** of a small quantity of molten wax is made into the top of cavity **14**. By the term "small" it is meant that the amount of wax in the second pour is a small percentage of the quantity of wax in the first pour. Where the depth of cavity **14** is 86 mm, the pour will leave the upper 58 mm empty before insertion of the insert **12**. The formulation of the wax may be the same for both pours. With the second pour **46** still molten, insert **12** is lowered into cavity **14** of the inverted shell **10**,

displacing molten wax of the second pour **46** upwardly around the insert along the interior surface **15** of the cavity to form a bonding layer **20**. Insert **12** is pressed as far as possible into shell **10**, until the casing around upper surface **16** hits the top surface of the interior surface **15**. An air gap of about 30 mm extends upwardly from the bottom of shell **10** into cavity **14** around insert **12**. This helps prevent cracking.

[0023] The invention impedes the genesis and spread of cracks in the wax shell of a two component imitation candle. The assembly method for embedding insert **12** moves the point of maximum stress to a position where the stress is more readily tolerated. This is achieved by forming a gap between the insert and thin walled sections of the wax starting from a leading edge of the wax (e.g. the bottom edges of the shell). The gap can be air, or it can be filled with substances which offer insubstantial resistance to contraction of the wax as it cools. Leaving a gap between the bottom edge of the shell moves the point of maximum stress to an area of the shell where the gap ends and the bonding layer begins. This places the point of maximum stress away from any corners or edges. Cooling of the shell is also retarded here due to the greater local thermal mass, allowing more time for internal stress relief. The invention also achieves reduced concentration of stress by maintaining a maximum degree of uniformity in wax wall thickness and eliminating sharp corners.

[0024] While the invention is shown in only two of its forms, it is not thus limited but is susceptible to various changes and modifications without departing from the spirit and scope of the invention.